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BRIDGING ACADEMIC AND WORKING LIFE EXPERTISE IN CONTINUING PROFESSIONAL EDUCATION: A SOCIAL NETWORK PERSPECTIVE

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Abstract

This dissertation examined efforts to bridge academic and working life expertise in continuing professional education in response to the new requirements of changing world and working life contexts. Its specific aims were to examine the development of professional social networks; to explore the role of the learners' orientations towards expertise in terms of deliberate knowledge enhancement, problematising and knowledge building; and to examine interconnection of academic and working life expertise through guidance from more experienced actors. The studies were conducted in the context of two continuing professional training programmes: a diplomatic training programme, which represented old and traditional professional fields, and an energy efficiency training programme, which represented new and emerging professional fields. The data were collected using social networking questionnaires, interviews and diary methods and were analysed using social network analysis and qualitative content analysis. Altogether, 61 interviews were conducted.

Study I examined newly recruited diplomats' socialisation to the networked professional expert culture of the Ministry for Foreign Affairs of Finland over a six-month on-the-job training period as part of their preparation for service in the diplomatic corps. *Study II* examined the development of expert networks among all course participants and at small-group and individual levels in the context of a one-year energy efficiency training programme. *Study III* deepened the understanding of the knowledge exchange processes in the energy efficiency field by focusing on the key energy efficiency professionals positioned in the middle of the social network, who were more frequently sought out for professional advice than other trainees. *Study IV* examined a procedure involving two advisors (one from an academic context and the other from a working life context), who aimed to support the learning of the novel competencies required in the emerging field of energy efficiency.

The results revealed that social learning environments and networks bridging academic and workplace expertise can provide workers important resources for updating their expertise, especially in emerging fields. However, the practical needs of workplaces and the scientific viewpoints and standards of the academic world do not necessarily meet without friction when trying to find new forms of cooperation between higher education and working life. Therefore, shared standards and guidelines for organising education must be created to improve educational quality. In addition, participants' orientations towards adaptive expertise are particularly important for professional learning and for interconnecting academic and workplace expertise. In the future, continuing professional training programmes organised at the interface of education and working life could play an especially important role in emerging fields, in which there is lack of certified knowledge and established education programmes for developing expertise.

Keywords: c*ontinuing professional education, interconnecting academic and workplace settings, emerging fields, expert networks, adaptive expertise, professional guidance, social network analysis*

TURUN YLIOPISTO
Kasvatustieteiden tiedekunta, Opettajankoulutuslaitos

HYTÖNEN, KAISA: Akateemisen osaamisen ja työelämäasiantuntijuuden yhdistäminen korkea-asteen tutkinnonjälkeisessä koulutuksessa: Sosiaalisten verkostojen näkökulma.

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Tiivistelmä

Väitöskirjassa tutkittiin akateemisen ja työelämäasiantuntijuuden yhdistämistä korkea-asteen tutkinnonjälkeisessä koulutuksessa vastauksena työelämän työntekijöille asettamiin uusiin vaatimuksiin. Tutkimuksen tavoitteena oli analysoida sosiaalisten verkostojen kehittymistä sekä koulutuksen osallistujien asiantuntijuuden joustavuutta, jonka nähtiin liittyvän tarkoitukselliseen tiedon hankkimiseen, olemassa olevien käytäntöjen kriittiseen tarkasteluun sekä aktiiviseen tiedon rakentamiseen. Lisäksi tutkittiin akateemisen osaamisen ja työelämäasiantuntijuuden yhdistämistä kokeneiden asiantuntijoiden tarjoaman tuen avulla. Osatutkimukset toteutettiin kahdessa korkea-asteen tutkinnon jälkeisessä koulutusohjelmassa, joista diplomaattivalmennus edusti vanhoja ja perinteisiä ammatteja ja energiatehokkuusasiantuntijakoulutus uusia ja kasvavia ammattialoja. Aineisto kerättiin verkostokyselyjä, haastatteluja sekä päiväkirjamenetelmää käyttäen ja analysoitiin sosiaalisen verkostoanalyysin ja laadullisen sisällönanalyysin menetelmin. Kaiken kaikkiaan tutkimusprosessin aikana tehtiin 61 haastattelua.

Osatutkimuksessa I tutkittiin vastikään rekrytoitujen nuorten diplomaattien sosiaalistumisprosessia työyhteisönsä asiantuntijaverkostoihin ja -kulttuuriin Suomen ulkoasianministeriön järjestämään diplomaattivalmennukseen sisältyvän puoli vuotta kestävän osastoharjoittelun aikana. *Osatutkimuksessa II* tarkasteltiin ammatillisten verkostojen kehittymistä kaikkien vuoden mittaisen energiatehokkuusasiantuntijakoulutuksen osallistujien välillä, pienryhmätasolla ja yksilötasolla. *Osatutkimuksen III* tarkoituksena oli syventää ymmärrystä energiatehokkuusalalla tapahtuvasta tiedon vaihdosta keskittymällä niihin avaintoimijoihin, jotka sijoittuivat energiatehokkuusasiantuntijakoulutuksen sosiaalisten verkostojen keskiöön ja joilta haettiin ammatillista apua useammin kuin muilta koulutuksen osallistujilta. *Osatutkimuksessa IV* puolestaan analysoitiin kahden ohjaajan mallia, jonka avulla pyrittiin tukemaan energiatehokkuusalalla tarvittavien uusien tietojen ja taitojen oppimista tarjoamalla osallistujille ohjaaja sekä yliopistosta että työelämästä.

Tulokset osoittivat, että akateemista osaamista ja työelämäasiantuntijuutta yhdistävät sosiaaliset oppimisympäristöt ja verkostot voivat tarjota tärkeitä resursseja asiantuntijuuden päivittämiseksi erityisesti sellaisilla aloilla, joilla kehitys on nopeaa. Työpaikkojen käytännölliset tarpeet ja akateemisen maailman tieteellinen näkökulma eivät kuitenkaan välttämättä kohtaa kehitettäessä uusia yhteistyön muotoja korkeakoulutuksen ja työelämän välille. Yhteisiä standardeja ja ohjenuoria tulisikin luoda, jotta koulutuksen laatua voidaan parantaa. Lisäksi joustava asiantuntijuus on tärkeää ammatillisen kehittymisen sekä akateemisen osaamisen ja työelämäasiantuntijuuden yhdistämisen kannalta. Koulutuksen ja työelämän risteyksessä järjestettävällä korkea-asteen tutkinnonjälkeisellä koulutuksella näyttää olevan erityisen tärkeä merkitys aloilla, joilla ei vielä ole vakiintunutta tietämystä ja koulutusmalleja asiantuntijuuden kehittymisen tueksi.

Asiasanat: *korkea-asteen tutkinnonjälkeinen koulutus, akateemisen osaamisen ja työelämäasiantuntijuuden yhdistäminen, uudet ja kasvavat alat, asiantuntijaverkostot, joustava asiantuntijuus, ammatillinen ohjaus, sosiaalinen verkostoanalyysi*

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Turku, October 2016

Kaisa Hytönen

List of original publications

This doctoral dissertation is based on the following original publications, which are referenced in the text by their Roman numerals.

Study I Hytönen, K., Hakkarainen, K., & Palonen, T. (2011). Young diplomats' socialization to the networked professional cultures of their workplace communities. *Vocations and Learning, 4*, 253–273.

Hytönen contributed to the study conception and design, data collection, analysis and interpretation, and was responsible for the writing of the manuscript. Hakkarainen contributed to the study conception and design, data analysis and interpretation, and revision of the manuscript. Palonen contributed to revision of the manuscript.

Study II Hytönen, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2014). Does academic apprenticeship increase networking ties among participants? A case study of an energy efficiency training program. *Higher Education, 68*, 959–976.

Hytönen contributed to the study conception and design, data collection, analysis and interpretation, and was responsible for the writing of the manuscript. Palonen contributed to the study conception and design, data collection, analysis and interpretation, and revision of the manuscript. Lehtinen contributed to the study conception and design, and revision of the manuscript. Hakkarainen contributed to the study conception and design, and revision of the manuscript.

Study III Hytönen, K., Palonen, T., & Hakkarainen, K. (2014). Cognitively central actors and their personal networks in an energy efficiency training program. *Frontline Learning Research, 2*, 15–37.

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Study IV Hytönen, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2016). Between two advisors: Interconnecting academic and workplace settings in an emerging field. *Vocations and Learning, 9*, 333–359.

Hytönen contributed to the study conception and design, data collection, analysis and interpretation, and was responsible for the writing of the manuscript. Palonen contributed to the study conception and design, data analysis and interpretation, and revision of the manuscript. Lehtinen contributed to the study conception and design, and revision of the manuscript. Hakkarainen contributed to the study conception and design, and revision of the manuscript.

1 Introduction

Our world is becoming increasingly complex. Its current state is characterised by globalisation, complexity and rapid change, as well as new kinds of problems and challenges that humankind must resolve. The novel challenges faced in contemporary society have changed working life, both by transforming the nature of existing professions and by producing totally new occupations and professional fields. Therefore, to be able to cope in these changing work environments and to solve complex professional problems, workers face a need to not only update their knowledge, skills and working attitudes, but also create novel expertise.

Traditionally, professional learning has been understood as the cumulative augmentation of expertise and knowledge within some specific professional field. However, during this time of unpredictable working careers, this kind of vertical development of expertise is not sufficient. Instead, professionals are expected to constantly update and horizontally grow their skills and competencies to harness wide-ranging expertise that crosses the boundaries of different domains. Expertise acquired through formal education at the beginning of a working career may not be sufficient on its own; however, in many cases, workers encounter a need to change the nature and focus of their professional profile. The need for continuous professional learning does not only concern young workers at the beginning of their careers; it also concerns more experienced professionals who have already many years of working experience (see Billett, 2012; Billett & Pavlova, 2005; Fenwick, 2012; Redecker et al., 2010).

Professionals' own active orientations towards extending their skills and competencies in order to dynamically adapt to transforming environments play an important role in their successful professional activity. In addition, the more complex, changing and uncertain the working environment is, the greater the need is to collaborate and create professional networking connections (Hakkarainen et al., 2004; Nooteboom, 2004). Being a member of a professional social network, in addition to having versatile personal networking connections, ensures access to critical know-how and competencies and plays a central role in professional development.

Rapid and extensive changes have increased complexity in working life, professions, professional knowledge cultures and ways of working taking place both globally and locally, causing challenges not only for workers, but also for professional education and workplaces. The central questions raised in recent studies include: How should professionals be prepared to meet the new challenges of future working lives and supported in updating their expertise? Furthermore, how can educational institutions address changing educational demands and provide training for new professions (Lehtinen, Hakkarainen, & Palonen, 2014; Palonen, Boshuizen, & Lehtinen, 2014)? Both educational institutions and workplaces need to rethink and transform the ways in which competencies are developed and cultivated. Especially in emerging fields, the lack of shared and certificated knowledge, recognised experts and accredited institutions create challenges for organising education.

Recently, it has been acknowledged that deeper interactions and partnerships between higher education institutions and working life could provide one possible answer for meeting future educational challenges (Billett & Henderson, 2011; Gijselaers, Dailey-Hebert, & Niculescu, 2013; Harteis, Rausch, & Seifried, 2014; Jensen, Lahn, & Nerland, 2012; Kessel & Kwakman, 2007; Tynjälä, Välimaa, & Sarja, 2003; Välimaa, 2006). Even though becoming a professional is acknowledged to be a process of fusing the theoretical and practical elements of professional knowledge (Bromme & Tillema, 1995), these two components have traditionally been separated in educational and working life practices. Educational institutions have provided theoretical knowledge bases for workers, whereas workplaces have historically been important places for cultivating and developing professional skills and practices (Tynjälä, 2013; Eraut, 2007). In particular, models of continuing education have been either purely work-based or theoretical in nature. As such, these educational systems may not be sufficient for developing the capacities needed to manage novel and transforming professional practices in emerging fields and changing working environments (Choy, Smith, & Kelly, 2014). In addition, only a few workplaces are able to provide opportunities for improving conceptual and other knowledge-laden aspects of professional competencies and, thereby, to provide possibilities for learning novel skills and complex capabilities (Billett, 2014; Korkeakoulutettujen oppisopimustyyppiset täydennyskoulutukset, 2010). Consequently, new ways of combining the scientific knowledge and expertise of universities and the know-how of experts in workplace settings could help to generate new learning solutions, develop and distribute new kinds of competencies and innovations, create diverse professional collaboration networks and, therefore, prepare workers to cope in their future working lives.

This doctoral dissertation examines efforts of bridging academic and working life expertise in continuing professional education in response to the new requirements of the changing world and working life contexts. The studies are conducted in the context of one old, traditional field and one emerging field, in which workers face new kinds of requirements, such as the rapid creation and enhancement of knowledge and the need to flexibly acclimatise to life despite continuous instability and uncertainty.

1.1 Changing working life–changing expertise

The nature of professional work has changed. Professionals must be able to solve unforeseen complex and global problems related to, for example, climate change, global warming, uncertainty about global safety, overpopulation, sustainable food production, immigration, deepening income inequality and poverty (Facer, 2011; World Economic Forum, 2016). Overcoming these challenges, for which there are no standardised solutions, increases the need for a new kind of expert knowledge and calls for novel ways of interpreting the world. Professionals are required to reconsider their professional practices and competencies, as well as to find new methods of professional learning and development (Ohlsson, 2011). Relying on once-acquired

expertise, routines or monotonic learning that has worked adequately in the relatively stable and slowly changing professional environments of the past is not sufficient for meeting new challenges. Instead, a novel way of alternating between and linking studying, learning and gaining working experience is needed to acquire resources for maintaining, developing and updating necessary skills (Billett, 2014). In today's professional work, there is often no direct link between the length of the professional career and the level of competence that is here understood as integrated set of capabilities needed for effective performance and problem solving in certain professional contexts (Mulder et al., 2009). Thus, many professionals who are not "experts" in the traditional sense of the word, can be characterised as "experienced non-experts" rather than experts (Bereiter & Scardamalia, 1993; Ericsson, 2006).

Various dimensions of expertise have been described for example by using the concepts of T-shaped expertise (Davies, Fidler, & Gorbis, 2011), hybrid expertise (Howells, 1998) and relational expertise (Edwards, 2010). Davies et al., (2011) define the ideal future worker as T-shaped, meaning that the worker has deep understanding of at least one professional field, but is also able to speak the language of a broader range of disciplines. The T-shaped quality of expertise is necessary to face today's multifaceted global problems, which are too complex to be solved within the framework of a single specialised discipline. Instead, multidisciplinary solutions and approaches are required. The ability to interconnect, modify and bridge skills, knowledge and experiences over professional fields, as well as to integrate previously separate bodies of knowledge and competence, is called hybrid expertise (Howells, 1998). Relational expertise, instead, can be understood as the capability to recognise the importance of resources provided by different actors, the relevance of generating mutual understanding and shared goals and the ability to productively tailor and fine-tune personal expertise to create joint or shared competencies within communities and organised groups of experts (Edwards, 2010). Collaborations among different fields of expertise call for relational expertise.

In this dissertation, the concept of adaptive expertise is used to characterise professionals who are oriented towards extending their skills and competencies in order to dynamically adapt to transforming professional environments, based on the approaches of Hatano and Inagaki (1986), Ericsson (2006) and Ohlsson (2011). When preparing for demanding emerging professional practices, workers' own deliberate efforts to intentionally improve their skills, adapt to changing environments, work at the edge of their competencies, expand their learning beyond formal education and regulate and reflect on their individual behaviours are important (Davies et al., 2011; Ericsson, 2006; Trede & McEwen, 2016). The professional activity of adaptive experts involves investing effort into actively seeking out challenges that provide new learning opportunities, obtaining in-depth conceptual understandings of the problems encountered, working at the edge of one's competence and constantly stretching performance to continue learning, all while self-regulating and reflecting on evolving professional competencies (Bereiter & Scardamalia, 1993; Hakkarainen, 2013;

Ohlsson, 2011; Paavola, Lipponen, & Hakkarainen, 2004). Professionals with strong orientations toward adaptive expertise are likely to develop tight ethical and normative criteria for their professional conduct (Gardner, Csikszentmihalyi, & Damon, 2001) as well as to systematically question and problematise prevailing routines and practices to find alternative solutions and novel perspectives (Mustonen & Hakkarainen, 2015). Moreover, adaptive expertise may be understood as adopting an innovator's social role in the workplace community (Mieg, 2006) and creating networking connections with proximal and distant experts and expert communities that are important for coping in turbulent working environments (Hakkarainen, 2013; Hakkarainen et al., 2011). To conclude, the concept of adaptive expertise is used in this dissertation to refer to a professional's personal efforts to deliberately acquire knowledge and improve his or her professional competence, seek alternative solutions for existing professional practices and become an active knowledge-building and networking actor in his or her professional field in order to reach the highest levels of professional competence.

1.2 Transforming professional knowledge cultures in emerging and traditional fields

The knowledge society comprises different kinds of knowledge cultures. The concept of epistemic culture has been used to describe the characteristics of the knowledge creation, organisation and communication practices of certain scientific and professional fields. Recent research has focused on examining the differences between the knowledge cultures of various scientific or professional fields and disciplines (Knorr Cetina, 1999; Knorr Cetina & Reichmann, 2015; Nerland, 2012). Profession-specific ways of approaching, producing, distributing, validating and applying knowledge create a basis for how professionals see the world and how they arrange their professional activities. Accordingly, professional knowledge cultures affect the ways in which professional problems are reasoned, understood and handled through the use of epistemic practices that denote field-specific tools and practices for handling knowledge (Jensen, Nerland, & Enqvist-Jensen, 2015; Nerland, 2012). Simultaneously, working with increasingly complex problems and challenges requires increased integration of professional and scientific knowledge.

In recent decades, the relationship between knowledge production and application has grown closer and more blurred. This change has been called a shift from Mode1 to Mode2 knowledge production (Gibbons et al., 1994; Novotny, 2003). Mode1 knowledge production operates within a single disciplinary context and does not aim to apply knowledge into practice. By contrast, Mode2 knowledge production involves knowledge that is produced, generated, validated and shared in heterogeneous organisations and larger professional communities by bringing together versatile expertise and different kinds of knowledge dimensions. This means that, in Mode2, various professional knowledge cultures grow closer, crossing the borders between different and heterogeneous professions.

Recent studies have identified different driving forces transforming existing jobs and leading to the emergence of new professional fields and the hybridisation of existing professions. These professions are related to new societal needs and challenges, technological development, innovations and changes in legislation (Davies, Fidler, & Gorbis, 2011; Palonen, Boshuizen, & Lehtinen, 2014; Talwar & Hancock, 2010). It appears that the features of Mode2 knowledge production, such as multidisciplinarity, the creation of novelty in the context of application and an orientation toward societal impacts, are typical for emerging fields. Energy efficiency is an excellent example of a new and rapidly developing field of professional activity that can be considered representative of Mode2 knowledge production.

Developing efficient energy usage practices, which aim to save energy in different areas of consumption, reduce costs of energy production and protect the environment, is one of the most important challenges of the twenty-first century. Like many other new professions, the field of energy efficiency has emerged through the intersection of several professional domains, meaning that a unified system or shared body of common knowledge to direct professional activity does not yet exist (Carlile, 2004; Edwards, 2012). In addition, standard educational methods or practices for cultivating expertise have yet to be established (Vest, 2008). It follows that knowledge is distributed in global networks and beyond the boundaries of different professions and cooperation among professionals mastering varying bodies of expertise is important. Actors working in the field are required to significantly deepen their expertise to meet emerging demands for and changing legislations on efficient energy usage. Local working is, in a concrete way, integrated with national and global efforts because the shared standards and work-based practices defined by the European Union (EU) and other multinational organisations are routinely used at the local level (Fourcade, 2006).

As is typical of Mode2 knowledge production, professional knowledge and its development in the field of energy efficiency (see similar situations in other engineering fields; e.g. Nerland, 2012) are linked to the pursuit of technological inventions and achievements, as well as their application to practical problems. The problems that serve as the focus of energy efficiency professionals' work are typical epistemic objects that become infinitely more complex and generate new questions the more they are examined (Knorr Cetina, 2001). Consequently, there are no ready-made or clear-cut operational resolutions, and energy efficiency workers are required high levels of creativity and experimental attitudes to solve their complex professional problems. Thus, combining scientific knowledge with professional work plays an important role in this field.

Societal developments and changes in working life also affect traditional fields. Even though the rate of change is not necessarily as rapid in traditional fields as in emerging fields, they cannot straightforwardly be seen as representatives of Mode1 knowledge production environments but, instead, moving closer to Mode2 knowledge production features. The diplomatic profession is one example of old and traditional

professional fields in which the nature of the professional work has changed not only in Finland, but also elsewhere in Europe and throughout the global knowledge society. Historically, diplomatic careers have proceeded gradually, such that members of the field begin in a variety of duties and positions that move slowly towards ambassadorship. This progress may take up to two decades. Today, however, diplomatic work has become more hectic and rapid in nature. Furthermore, the hierarchy characteristic of the diplomatic profession has diminished. In diplomatic careers, the instructions and guidance of more experienced workers, which mediate core knowledge about the diplomatic knowledge culture, are important for newcomers' engagement in the profession (see Jensen, Nerland, & Enqvist-Jensen, 2015). However, because of the rapidly transforming global and globalising environment of activity and the increasing complexity of international relationships, young diplomats no longer know to which kind of diplomatic career they are committing themselves. They will face totally new professional challenges by the time they reach the peak of their careers. Therefore, personal capacities to grow, develop and transform have become some of the most important characteristics of diplomats. In addition, one's ability to be a part of a professional network is crucial, since, in today's changing and turbulent environment, professional development is deeply embedded in the deliberate creation and cultivation of versatile professional connections. Overall, diplomats need to be able to operate at the intersection of various knowledge cultures and to master versatile know-how related to, for example, societal, political and financial questions at the local and global levels. It seems that these two challenges—securing the engagement of professionals in profession-specific knowledge and creating opportunities to exceed local working environments and local work practice boundaries in order to extend knowledge, are particularly central in rapidly changing working environments and cultures (Jensen, Lahn, & Nerland, 2012).

1.3 Interconnecting learning in education and work

Even though differences in epistemic cultures have sometimes been seen as challenges or even obstacles for multidisciplinary work (Mørk et al., 2008; Wagner & Newell, 2004), it is typical in today's knowledge society for knowledge to be generated and shared in wider professional communities, often in collaboration with academic and other expert communities. This phenomenon is referred to as the spill-over of epistemic cultures, meaning that many non-academic contexts and professional areas of knowledge outside universities and research institutes also produce and apply theoretical and experience-based expert knowledge (Knorr Cetina & Reichmann, 2015). In other words, today's professional knowledge cultures seem to exceed the traditional boundaries of education and work (Akkerman & Bakker, 2011).

Workplaces have traditionally been important places for cultivating and developing professional skills (Eraut, 2007; Tynjälä, 2013). Practice settings can provide a range of situation-specific experiences and enable the cultivation and sharing of efficient techniques and practices (Billett, 2008; Choy, Smith, & Kelly, 2014).

However, only a few workplaces are able to provide opportunities for improving conceptual and other knowledge-laden aspects of professional competencies—and, thereby, to provide opportunities to learn the novel skills and complex expertise needed in emerging fields (Billett, 2014; Korkeakoulutettujen oppisopimustyyppiset täydennyskoulutukset, 2010). Therefore, it has been acknowledged that deeper interactions and new forms of cooperation among higher education institutions and working life—that is, efforts to combine the scientific knowledge and expertise of universities with the know-how of experts in workplace settings—could help to develop and distribute new kinds of competencies and innovations, thus yielding a possible solution for meeting future educational challenges (Billett & Henderson, 2011; Jensen, Lahn, & Nerland, 2012; Kessels & Kwakman, 2007; Mustonen & Hakkarainen, 2015; Tynjälä, Välimaa, & Sarja, 2003; Välimaa, 2006).

Coping with the rapid changes in the knowledge society and working life seems to require closer integration of professional and scientific knowing. Partnerships between education and industry are already typical of vocational education, and the educational value of connecting learning within educational institutions with practice-based workplace experiences has been acknowledged for those who are beginning their professional careers (Billett & Henderson, 2011; Endedijk & Bronkhorst, 2014; Poortman et al., 2014). However, it is only recently that these kinds of partnerships have emerged in the fields of continuing professional education. The interconnection between the academic and working life settings can be seen as promising for supporting professionals who are already engaged in their working lives. The integration of theoretical and practical knowledge is one key element in achieving high-level expertise and could provide a fruitful basis for developing cutting-edge expertise and new working tools (Bromme & Tillema, 1995; Eraut, 2004). Thus, scientific knowledge and working life practices can be seen as jointly constituting a given field of expertise (see Jensen & Nerland, 2015).

Advice and detailed feedback from more experienced and competent actors are important in the development of expertise (Gruber, Lehtinen, Palonen, & Degner 2008). In new and emerging fields, however, workplaces are rarely able to provide other experts or expansive, supportive and challenging learning environments to help workers grow (Evans et al., 2006; Fuller & Unwin, 2004a). In such cases, advisors from outside the workplaces may play a critically important role in facilitating professional learning (Hughes, 2004). One example of how guidance can be shared between education and work to support professional learning is work-based doctorate programmes, in which the responsibility of supervision is split between a university advisor and an internal or external specialist who has insights into contextual issues (Costley & Lester, 2012). It seems that integrating guidance from both academic and workplace contexts can provide benefits both for workers' personal and professional growth and for their employing organisations. In addition to successful guidance practices, recent research has also identified other critical aspects of learning taking place at the interface of education and work. These are related to, for example,

collaborations between educational institutions and workplaces, active participation encouraged by workplaces and good learning atmospheres (Tynjälä, Häkkinen, & Hämäläinen, 2014; Virtanen, Tynjälä, & Eteläpelto, 2014).

1.4 Social networks as learning contexts

Traditionally, in established and stable working environments and professional fields, workers have become involved in existing cultural knowledge, experiences and practices that are stored in social structures and mediated through collaboration (Brown et al., 2005; Orr, 1996). However, rapidly changing and complex environments typically lack a formal professional knowledge base, jointly shared standards and best practices. Therefore, professional development in such fields is, to a great degree, embedded in the deliberate creation and cultivation of versatile network relations.

Social relationships and networks play extremely important roles in explaining the processes of knowledge creation, dissemination and use because they affect individuals' and collectives' abilities to access, transfer and apply knowledge (Phelps, Heidl, & Wadhwa, 2012). According to the homophily principle, people often interact and create strong ties with others who have characteristics similar to their own (e.g. in terms of gender, age, educational level, professional group and structural position) (Kleinbaum, Stuart, & Tushman, 2013; Lozares et al., 2013; McPherson, Smith-Lovin, & Cook, 2001; Reagans, 2011; Zappa & Robins, 2016). It follows that networks are often homogeneous in nature. Homogeneous professional networks, however, do not provide adequate ways of coping with the challenges involved in profound transformations of professional practices extending across multiple fields. Even though becoming and being an expert professional actor requires individuals to become members of occupational professional networks, collaborating solely with people with similar backgrounds and relying on field-specific linkages is not sufficient to solve complex and diversified problems. Instead, professionals must engage in knowledge sharing and collaborative knowledge creation through multi-professional teams and with other professionals specialising in varying bodies of expertise and pursuing divergent professional tasks and projects (Akkerman et al., 2006; Edwards, 2010; Hakkarainen et al., 2004).

Multi-professional networks that are organised at the interface of different working cultures may provide forums for the sharing and receiving of critical knowledge between people with different types of expertise and professional competencies (Hytönen & Tynjälä, 2005; Roxå, Mårtensson, & Alveteg, 2011). Therefore, the added value of interconnecting academic and working life expertise may be the creation of a networking forum for professionals to cultivate their skills, share expertise and create new professional connections. However, recent studies have shown opposite results regarding the emergence of learning networks in blended learning environments (Rienties et al., 2014; Rienties, Heliot, & Jindal-Snape, 2013). It seems that networking connections do not appear automatically; instead, conditions and processes that make communication and collaboration across organisational

boundaries and epistemic cultures productive need to be created. In addition, different kinds of attributes related to, for example, the structures of networks and relational and cognitive issues influence knowledge sharing in knowledge networks (Akhavan & Hosseini, 2015).

The nature of workers' personal networking connections seems to be important for engaging in professional activity and updating expertise. In today's knowledge economy, in order to acquire new knowledge and appropriately novel professional practices, as well as to find necessary professional help and advice, experts must rely on their personal social networks, reaching beyond the boundaries of their workplace organisations, rather relying merely on traditional institutional resources (Nardi, Whittaker, & Schwarz, 2000). Thus, the process of deliberately building and extending personal networks provides workers access to important knowledge resources, professional support and opportunities for informal learning (Lin, 2001).

Persons who are positioned in the middle of professional social networks—and, therefore, in the middle of the communication structure—play crucial roles in coping with changing professional requirements. In the literature, professionals with central networking positions, who possess, mediate, translate and transmit knowledge and good professional practices, have been called, for example, knowledge brokers (Sverrisson, 2001), gatekeepers (Morrison, 2008), stakeholders (Krueger et al., 2012; Svendsen & Laberge, 2005), stars (Borgatti et al., 2009) and hubs (Barabási, 2002). These individuals create connections between different people and diverse cultures, build bridges across different bodies of knowledge and match their expertise with other people's competencies (Burt, 1999; Palonen et al., 2004). Therefore, these key experts, who have access to extended pools of knowledge and diverse sources of information, are often considered to be exceptionally valuable networking partners and collaborators. As a consequence, they are the most often sought out for advice and assistance by those struggling with novel professional challenges. In this dissertation, these key experts, whose cognitive achievements are shared by their professional peers, are called "cognitively central actors". This concept is derived from studies on group decision making in the social network framework (Kameda, Ohtsubo, & Takezawa, 1997; Stasser, Abele, & Vaughan Parsons, 2012).

As discussed above, professional knowledge networks are multilevel by nature. Specifically, they are combined at the levels of individuals, groups and organisations. Traditionally, knowledge network research has focused primarily on single levels of analysis, adopting one perspective at a time to examine network properties (Phelps, Heidl, & Wadhwa, 2012). This dissertation aims to overcome this limitation by adopting a multilevel approach to professional expert networks and their development. It examines social connections at the interface of academic and practical settings by focusing simultaneously on the individual, group and network levels. Different network elements related to the structural properties of personal and overall networks, as well as the properties of network members and their relations, are examined (see e.g. Palonen & Hakkarainen, 2014; Scott, 1991; Wasserman & Faust, 1994).

2 The aim of the study

The aim of this dissertation was to examine efforts to bridge academic and working life expertise in continuing professional education in the context of one traditional and one emerging field in response to the new requirements of the changing world and working life contexts. The aim was approached through the following research questions:

1. What kinds of structures, processes and activities of professional social networking exist at the interface of academic and workplace settings? Are these two contexts interconnected in professional social networks? (Studies I, II and III)

2. Is a learner's orientation toward expertise in terms of deliberate knowledge enhancing, problematising and knowledge building activities related to the interconnection between academic and working life expertise, and if so, how? (Studies I, III and IV)

3. How is professional learning supported by more experienced actors and are there differences between traditional and emerging fields? Does the interconnection of academic and workplace expertise occur through guidance practices? (Studies I and IV)

These sub-studies were conducted in the context of two continuing professional training programmes. The diplomatic training programme represents old and traditional professions, and the energy efficiency training programme represents new and emerging professional fields. Study I was conducted in the context of the diplomatic training programme, and Studies II, III and IV were conducted in the context of the energy efficiency training programme. *Study I* examined young diplomats' socialisation to the networked professional expert culture of the first workplace community of their diplomatic career over a six-month, on-the-job training period as part of their preparation for service in the diplomatic corps. *Study II* examined the development of professional social networks in the context of a one-year-long energy efficiency training programme. Here, the development of professional social networks was examined at an overall network level (i.e. among all course participants), at a small-group level and at an individual level. *Study III* aimed to deepen existing understanding about social networking processes and knowledge exchange in the field of energy efficiency by focusing on those key energy efficiency professionals who were positioned in the middle of the studied social networks and who were sought out for professional advice more often than the other trainees: that is, those persons who achieved cognitively central positions. The study examined the features that were relevant for achieving this cognitively central position as well as the structure and heterogeneity of the key participants' personal social networks. Finally, *Study IV* examined a procedure involving two advisors—one from academic context and the

other from a working life context—that aimed to support the learning of the new knowledge and skills necessary in the emerging field of energy efficiency by interconnecting academic and workplace settings. In particular, the way in which the trainees' orientations toward adaptive expertise predicted the success of the guidance process, whether the interconnection of the two settings occurred through guidance practices and the features underlying successful guidance processes were studied.

3 Methods

3.1 Context

Study I was conducted in the context of the Training Course in International Affairs for Newly Recruited Diplomats (hereafter, "the diplomatic training course"). This course is a two-year, higher-education-level study program organised by the Ministry for Foreign Affairs of Finland, which qualifies participants for diplomatic careers. It involves study modules and practical training periods. Study I was undertaken during the first six months of full-time departmental training. Each trainee completed departmental training in one of the units that functioned within the framework of the Ministry's 12 departments.

Studies II, III and *IV* were carried out in the context of a one-year-long academic apprenticeship education programme in the field of energy efficiency (hereafter, "the energy efficiency training"). This training programme, along with other similar programmes, serves as a new model for further education funded by the Ministry of Education and Culture in order to develop extensive continuing education on a national level. These training programmes address the requirements for future education in different professional fields.

The energy efficiency training was a pilot educational programme, which was organised for the first time in Finland in 2011. This programme was organised in collaboration with three technical universities. Universities A (n = 29) and B (n = 28) organised education for actors working in the public sector, while University C (n = 30) organised education for actors working in the private sector. The energy efficiency training aimed to support the cultivation of energy efficiency expertise, promote professional networking among the actors in the field and encourage the sharing of good professional practices. It was based on real-life working practices and included theoretical studies and workplace learning. In their workplaces, the course participants pursued developmental project that aimed to bridge the theoretical and practical aspects of energy efficiency and the course participants' working assignments. The course participants were provided professional guidance in the academic and workplace settings to enable them to complete the study project and to support learning. Each participant was assigned an academic advisor from his or her organising university, as well as a workplace advisor from his or her workplace organisation. The role of the academic advisors was to support the participants in their study projects by providing scientific knowledge, discussions and information about valuable source books. The workplace advisors, in turn, were expected to support the course participants in their workplace learning processes, to promote their professional development in the context of the participants' individual assignments and to guide the preparation of the study projects from the perspective of the organisational goals.

3.2 Participants

The participants of *Study I* were the four trainees of the diplomatic training course, as well as all employees of the workplace communities in which they were pursuing their departmental training. Although four trainees took part in the study, this article focused only on one female ("Miia") and one male ("Sami") due to their representative networking positions. Miia's structural networking position in the department's social networks was fairly peripheral, as were those of the two trainees not reported in the article. However, in comparison with Miia and the two other trainees, Sami held an exceptionally central position during the training. In Miia's workplace community, there were 10 members, and in Sami's workplace community, there were 12 members, including diplomatic professionals and administrative staff, who participated in the study.

In *Study II*, a social networking questionnaire was sent to all 87 course participants (42 males, 28 females) of the energy efficiency training at the beginning of training and to all 74 course participants (50 males, 24 females) at the end of the training. The participants included engineers, architects and other professionals with master's- or bachelor's-level education and varied lengths of professional experience in practices related to energy efficiency. In addition, semi-structured interviews were conducted with the three training organisers, one from each organising university.

Study III was conducted at three levels of analysis. At the overall level, the participants comprised 74 course participants who remained at the end of the training. At the ego-alter level, the participants comprised the 40 members of the central participants' personal networks (24 males, 16 females) within the energy efficiency training course. At the ego-level, the participants comprised six cognitively central actors (2 males, 4 females) in the energy efficiency training course.

The participants of *Study IV* comprised 18 course participants (11 males, 7 females), 8 of their academic expert advisors (5 males, 3 females) and 8 workplace advisors (5 males, 3 females). The course participants represented different age groups and had different educational backgrounds, as well as different levels of energy efficiency-related experience (based on their job descriptions).

3.3 Social network methods

The study relied on a mixed methods approach (Creswell & Plano Clark, 2007; Johnson & Onwuegbuzie, 2004), which combined the quantitative and qualitative data collection and analysis methods. Combining these methods facilitates a better understanding of the examined networking and learning processes at the interface of the academic and workplace settings and an analysis of the phenomenon at different levels and from different perspectives. Quantitative social network methods were used in Studies I, II and III. The social network data facilitated the examination of the social structures and prevailing social relations, as well as their development, in the two professional training contexts.

Study I. The social network data were collected by administering a printed version of a social networking questionnaire to all professional members of Miia's and Sami's workplace communities at the end of the six months of departmental training. In Miia's workplace community, 8 out of 10 employees responded to the questionnaire (response rate = 80%). In Sami's workplace community, 9 out of 12 professionals responded to the questionnaire (response rate = 75%). In relation to one another, the participants indicated whether or not they 1) asked for advice regarding issues of professional substance, 2) asked for advice regarding practical professional problems, 3) sought new professional ideas and/or novel work-related information, and 4) sought guidance regarding their job descriptions and professional tasks. In addition, the participants described with whom they 5) collaborated, 6) discussed and exchanged professional thoughts, and 7) interacted with informally.

The network data were analysed using the UCINET 6 program (Borgatti, Everett, & Freeman, 2002). To simplify the data analysis, the seven networks were merged into three types: knowledge-acquisition networks (networks 1, 3, and 4; correlations varied between .409 and .593); practical know-how networks (network 2), and professional collaboration networks (networks 5, 6, and 7; correlations varied between .425 and .651). The cohesion of the three networks was analysed according to density and centrality measures. The networks' centralisation and the participants' centrality were measured using Freeman's degree. The proximity of the network members was analysed according to multidimensional scaling (MDS) techniques. Geometric network distances determined by MDS were visualised using the NetDraw program.

Study II and III. Network data were collected by administering an online social networking questionnaire to all course participants twice during the energy efficiency training. The pre-questionnaire was sent to 87 course participants at the beginning of the training; of these, 63 responded (response rate = 72%). After excluding the 13 participants who dropped out of the course, the post-questionnaire was sent to 74 course participants at the end of the training; of these, 52 responded (response rate = 70%). The respondents were asked to assess 1) from whom they sought advice regarding energy efficiency (advice-seeking network) and 2) with whom they collaborated in terms of energy efficiency activities (collaboration network). To measure the strength of the networking relations, the respondents were asked to rate each of these items on a valued scale comprising 0 (no connection), 1 (a connection) and 2 (a strong connection).

The social network analysis was conducted via UCINET 6. In *Study II*, all analyses were conducted for the data provided by both the pre- and post-social networking questionnaires to examine the development of the network relations. The data were analysed at three levels. At the overall network level, the network cohesions of the advice-seeking and collaboration networks were analysed using density and centralisation measures. Density characterises the general cohesion of a network (i.e. the number of networking ties), whereas centralisation indicates the tie distribution among participants. The overall network connections were visualised using the Spindel

visualisation tool by relying on participants' geometric network distances determined through MDS techniques. Multiple regression quadratic assignment procedures (MRQAP) were used to analyse how much of the variance in new tie creation during the training was explained by the participants' backgrounds or prior ties. At the small-group level, the densities of the advice-seeking and collaboration networks were calculated among small group members. Hierarchical cluster analyses were used to determine the subgroups that existed among participants in the beginning and at the end of the training (see Scott, 1991). At the individual level, Freeman's degree measurement was calculated to reveal how often and for how many colleagues a given participant provided pieces of advice (Borgatti et al., 2002). These analyses were focused on peer evaluations, which, by indicating the number of incoming networking linkages, provide more reliable estimations of individuals' centrality than self-evaluations. Further, a repeated-measures ANOVA was used to analyse the changes in the number of advice-seeking and collaboration ties at the individual level throughout the training.

In *Study III*, a social network analysis was conducted at the overall network level and the ego-alter level. At the overall network level, the advice-seeking network was used to identify the cognitively central participants in the training. The advice-seeking network serves as a good indicator of a person's cognitive centrality because it is asymmetric in nature and does not require reciprocal networking connections (Palonen et al., 2004; Sparrowe et al., 2001). The cognitive centrality was examined by calculating the centrality value of advice-asking (i.e. advice size), using Freeman's in-degree measurement (see Palonen et al., 2004). This revealed the number of course participants who sought energy efficiency advice from the actor in question and, therefore, how significant a role the actor's expertise played in the social network. This supported the identification of the cognitively central actors. Further, the network cohesion of the overall advice-seeking network was analysed via a density measure. To illustrate the structure of the overall network for all course participants and the structural positions of the cognitively central participants, the advice-seeking and collaboration networks were visualised using the Spindel visualisation tool (www.spindel.fi) according to the participants' network distances, which were calculated using MDS techniques.

At the ego-alter level, the structure and heterogeneity of the central participants' personal networks were examined. The advice-seeking and collaboration networks were merged for these analyses. The egocentric network was used as the unit of analysis. The structure of the central participants' personal networks was analysed in terms of size, density and a brokering index. The Mann-Whitney U-test was used to analyse whether the structure of the central participants' personal networks differed from the structures of all other course participants' personal networks. The heterogeneity of the central participants' personal networks was analysed by comparing the various properties of the different alters, as well as the properties of the egos and the alters. The central participants' personal networks were visualised using Cytoscape (www.cytoscape.org).

3.4 Event sampling, semi-structured interviews and qualitative content analysis

To complement the social networking data, qualitative data were collected through event sampling and semi-structured interviews. These qualitative data provided information about the participants' experiences, reflections and understandings regarding professional learning at the interface of academic and workplace settings, as well as about the revealed networking structures and properties.

Study I. Event sampling is a diary method in which participants provide frequent reports on the events and experiences of their daily lives (Bolger, Davis, & Rafaeli, 2003). Event sampling was used to repeatedly collect information about the diplomatic trainees' experiences and associated reflections regarding their functioning in and socialisations to the new workplace community across the training period. The participants were asked by email to respond to the same six questions at two-week intervals. The data collection took four and half months and produced 9 reports from Miia and 10 from Sami. The diary data allowed us to analyse how the contents of the reflections changed over the course of the training period and the socialisation process (Bolger, Davis, & Rafaeli, 2003; Reis & Gable, 2000). To complement the event sampling data, interviews with the diplomatic trainees were conducted at the end of the training period. The interview themes emerged partially from issues, questions and problems addressed in the event-sampling reports. These involved the diplomats' experiences with 1) the departmental training and 2) the actual realisation and methods of socialisation. Further themes included the young diplomats' 3) experiences of their positions in the workplace community and 4) success and developmental needs of initiation, as provided by the department.

Event sampling and interview data were analysed via qualitative content analysis. The interview data were first analysed by identifying contents corresponding to the research questions and clustering these thematic expressions according to three main categories: the participants' social support networks, the resources provided by the network and socialisation to the workplace community. The event sampling data were analysed using the emerged thematic categories.

Study II. The three organisers of the energy efficiency training were interviewed to determine how the operational practices of the training shaped and supported networking among the participants. The interviews were carried out after the training, and the data were content-analysed.

Study III. To complement the networking data at the ego level of analysis, semi-structured interviews were conducted with the six cognitively central actors of the energy efficiency training. These interviews were carried out to examine the features of the cognitively central participants and the possible reasons they achieved central networking positions among the energy efficiency workers. The interview themes addressed the participants' educational backgrounds, work experiences, current work assignments and professional roles in relation to energy efficiency; their reasons for attending the training; their views on the energy efficiency field; their networking with

the other course participants and other energy efficiency professionals; their future prospects of developing energy efficiency expertise and their own opinions regarding the possible reasons for their cognitive centrality. Qualitative content analysis was conducted by identifying expressions related to the themes of adaptive and relational expertise, knowledge culture dissemination and knowledge brokering.

Study IV. Semi-structured interviews were conducted twice with the course participants. The pre-interviews (n = 16) were conducted in the beginning, and the post-interviews (n = 18) were conducted at the end of the training. In addition, semi-structured interviews with the eight willing academic advisors and eight workplace advisors of the interviewed course participants were carried out after the training. Overall, the data in Study IV consisted of 50 interviews.

The data were analysed according to qualitative content analysis using the ATLAS.ti program. The interviews were examined from two perspectives: 1) the guidance process and 2) the course participants' orientations to adaptive expertise. The perspective of the guidance process was examined by extracting interview content using the codes interconnection of academic and workplace guidance and success of guidance process. The codes reflecting orientations toward adaptive expertise included: the intensity of deliberate practice, the problematisation of professional practices and efforts to build professional knowledge. These codes were used to categorise expressions drawn from the interviews. Next, based on the interview content, two independent researchers evaluated and then quantified the aspects of deliberate practice, problematising, knowledge building, the success of guidance process in academic and workplace contexts as well as the interconnection of academic and workplace guidance by giving each participant a score on three-point rating scale (1 = low score; 2 = medium score; 3 = high score). An inter-rater reliability analysis revealed that the agreement between the raters varied from moderate to perfect.

Further, Spearman's correlation coefficients were computed to explore the correlations between the scores representing the participants' levels of adaptive expertise and the success of the guidance processes in their academic and workplace settings. The interconnection between academic and workplace settings was examined using the ratings explained above. The analysis was enriched at the case level by focusing on those course participants (n = 5) whose guidance relationships with their academic or workplace advisors were successful, as well as on these advisors (n = 4). The analysis focused on identifying content describing factors behind successful guidance relationships in the academic and workplace contexts.

The methods used in each study are summarised in Table 1.

Table 1. Overview of the methods of the study

Study	Participants	Data collection	Data analysis
Study I: Young diplomats' socialisation	• 4 participants from the diplomatic training course, with a focus on two of them: "Miia" and "Sami" • 20 members of Miia's and Sami's workplace communities	• Social networking questionnaire • Event sampling • Semi-structured interviews (n = 2)	• Density and centrality analyses • Freeman's degree measurement • Multidimensional scaling • Qualitative content analysis
Study II: Does academic apprenticeship increase networking ties among participants?	• Pre-measure: 87 course participants (42 males and 28 females) of the energy efficiency training • Post-measure: 74 course participants (50 males and 24 females) • 3 organisers of the energy efficiency training	• Pre- and post-social network questionnaires • Semi-structured interviews (n = 3)	**Overall network level:** • Density and centralisation analyses • Multidimensional scaling • Multiple regression quadratic assignment procedures **Small group level:** • Density analysis • Hierarchical cluster analysis • Qualitative content analysis **Individual level:** • Freeman's degree measurement • Repeated-measures ANOVA
Study III: Cognitively central actors and their personal networks	**Overall level:** • The 74 course participants of the energy efficiency training **Ego-alter level:** • The 40 members of the central participants' personal networks **Ego level:** • The 6 cognitively central actors of the energy efficiency training	• Social networking questionnaire • Semi-structured interviews (n = 6)	**Overall network level:** • Freeman's degree measurement • Density analysis • Multidimensional scaling • Mann-Whitney U-test **Ego-alter level:** • Ego network analyses (e.g. examining size, density and brokering index) **Ego level:** • Qualitative content analysis
Study IV: Between two advisors	• 18 course participants • 8 academic expert advisors • 8 workplace advisors	• Pre- and post-semi-structured interviews with the course participants (n = 34) • Semi-structured interviews with the advisors at the end of the training (n =16)	• Qualitative content analysis • Quantification of qualitative data • Cohen's kappa measurement • Spearman's correlation coefficient measurement

4 Overview of the studies

4.1 Study I

Hytönen, K., Hakkarainen, K., & Palonen, T. (2011). Young diplomats' socialization to the networked professional cultures of their workplace communities. *Vocations and Learning, 4*, 253–273. doi:10.1007/s12186-011-9061-x

The aim of this study was to examine young, newly recruited diplomats' socialisation to the professional expert culture of the Ministry for Foreign Affairs of Finland over the course of a six-month on-the-job training period, which was part of their preparation for service in the diplomatic corps. In particular, the study aimed to analyse the social networking structures of the workplace communities in which the newly recruited diplomats completed their departmental training and their networking positions in order to characterise the young diplomats' social support networks and resources obtained, as well as the associated reflections regarding their functioning in and socialisations to the departmental workplace community.

The participants in this study comprised four participants from the diplomatic training course; however, the article focuses on only two of these because of their respective and representative networking positions. The data collection took part during the six months of departmental training and relied on social network questionnaires, contextual event sampling and theme interviews, which facilitated the analysis of socialisation processes at the personal, community and process levels. The data were analysed through the methods of social network analysis and qualitative content analysis.

The results indicate that, across the six-month training period, the young diplomats became involved in their workplace communities' networked expertise and were socialised to its expert culture, despite achieving different networking positions. The results revealed differences between the levels of collective operational practices in the workplace communities, as well as the natures of the assignments in which the young diplomats participated and for which they were responsible. The workplace communities also offered the young diplomats somewhat different learning opportunities.

It was proposed that these differences mirrored distinctions in the expansive natures of the young diplomats' workplace communities as learning environments (i.e. the amount of interactions between the participants and the collective operational practices in their workplace communities), as well as the natures of the work assignments for which the young diplomats were responsible. The results indicated that newcomers may move very quickly to the centre of a professional community if the community provides an expansive working culture and if the newcomer has a high degree of a personal agency. It seems essential to cultivate professional practices that provide newcomers immediate access to relevant information, assist in creating

versatile reciprocal networking relations, and engage newcomers in challenging working assignments. It is argued that organisational and professional socialisation can be most effectively supported through a culture of social interaction and participation.

4.2 Study II

Hytönen, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2014). Does academic apprenticeship increase networking ties among participants? A case study of an energy efficiency training program. *Higher Education, 68*, 959–976. doi:10.1007/s10734-014-9754-9

This article reported findings concerning the development of expert networks in the context of a one-year Academic Apprenticeship Education model in the field of energy efficiency. The model called Academic Apprenticeship Education was initiated in Finland in 2009 to address the requirements of future education in different fields of academic professional activity. Though networking is often foreseen and expected to have a positive effect akin to that of professional training, its actual influence has seldom been studied or reported. Therefore, the specific aim of this article was to examine the creation of networking ties among all course participants, the processes and structures of networking in small groups and individual participants' networking activities.

Data were collected by administering a social networking questionnaire to all course participants at the beginning (n = 87) and end (n = 74) of the energy efficiency training. The networking data were analysed using methods of social network analysis and a repeated-measures ANOVA. In addition, semi-structured interviews were conducted with three training organisers to examine how the operational practices of the training supported networking.

The results showed little change in the networking ties among all course participants. This indicates that the training did not effectively support comprehensive networking among the course participants, nor did it support the creation of an occupational exchange forum for energy efficiency professionals. However, those small groups that were able to communicate appeared to create internal linkages. An efficient small group work process appeared to be the best predictor for the emergence of professional network connections. At the individual level, more new ties emerged among private sector actors than public sector actors.

In conclusion, it was proposed that networking and knowledge sharing must be actively worked on and supported. The results indicated that shared standards and guidelines need to be created for the Academic Apprenticeship Education model in general. Educational quality might be better assured if the current ad hoc networks were not the only ways of organising knowledge exchange among the participants.

4.3 Study III

Hytönen, K., Palonen, T., & Hakkarainen, K. (2014). Cognitively central actors and their personal networks in an energy efficiency training program. *Frontline Learning Research, 2*, 15–37. doi: http://dx.doi.org/10.14786/flr.v2i2.90

This article examined cognitively central actors and their personal networks in the emerging field of energy efficiency. Cognitively central actors are key professionals who are frequently sought for professional advice by other actors and, therefore, are positioned in the middle of their social networks. These actors are often important knowledge resources, especially in emerging fields, in which standard knowledge exchange mechanisms are weak. Using a personal network approach, the cognitively central participants of the one-year energy efficiency training program were identified, the structure and heterogeneity of their personal networks were studied and the features that were relevant to achieving these cognitively central positions were determined.

Data collection relied on a social network questionnaire and semi-structured interviews. The social networking questionnaire was sent to 74 course participants at the end of the energy efficiency training. The data were analysed using methods of social network analysis. In addition, the semi-structured interviews were conducted for the six most central actors of the energy efficiency training, who were identified by networking methods. The data were analysed using qualitative content analysis.

The results revealed that, in relation to the other course participants, the cognitively central participants had larger and more sparse personal networks, indicating the essentiality of their knowledge mediation role. In addition, the personal networks of these cognitively central participants were rather heterogeneous in nature. Such heterogeneous resources are obviously necessary for coping with changing working environments. The results also showed that the six cognitively central actors differed from one another in many respects, including the duration of their working experience, their educational background, the extent of their involvement in energy efficiency and the kinds of organisations from which they came; in other words, there did not appear to be a single explanation for why these persons achieved their central positions.

In conclusion, it was proposed that becoming a cognitively central actor is an intricate process. It cannot be explained solely by personal attributes (e.g. actors' educational backgrounds, previous energy efficiency knowledge, fields of know-how or personal characteristics). Instead, to understand this phenomenon, it is necessary to study the organisations that cognitively central actors come from and the ways in which their expert profiles, which are related to their fields and competences, fit into the wider context of energy efficiency. Moreover, this study demonstrates the potential value of the personal network approach in researching professional knowledge exchanges in complex environments.

4.4 Study IV

Hytönen, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2016). Between two advisors: Interconnecting academic and workplace settings in an emerging field. *Vocations and Learning, 9*, 333–359. doi:10.1007/s12186-016-9156-5

This study examined a new training design for professional development that aims to support the learning of the novel knowledge and skills necessary in emerging professional fields by interconnecting academic and workplace settings. The training design is based on the involvement of two advisors: one from the working life context and the other from the academic context. The study examined whether participants' personal orientations towards adaptive expertise and deliberate practice predicts the success of a guidance process, as well as how guidance practices facilitate interconnections between workplace and academic contexts. In addition, the study analysed the features underlying the most successful guidance relationships.

Data were collected by conducting repeated semi-structured interviews with 18 course participants, eight academic advisors and eight workplace advisors over the course of a one-year energy efficiency training programme. The data were analysed according to qualitative content analysis using the ATLAS.ti program. The data were examined from the perspectives of 1) the guidance process and 2) the course participants' orientations towards adaptive expertise by extracting expressions from the interviews using five representative codes. Two independent researchers evaluated and then quantified the aspects of a three-point rating scale. The ratings were used for further analyses.

The results indicated that a trainee's personal orientation towards adaptive expertise is a significant determinant of guidance process success. Though workplace and academic knowledge and practices did not become interwoven through concrete guidance practices, many course participants were able to independently find ways to transition between the two contexts. The features underlying the most successful guidance relationships were found to be related at the personal, dyad and context levels.

In conclusion, the procedure of using two advisors seems to be a valuable method for preparing workers to meet the new requirements of their future working lives. However, this approach requires several different aspects of successful guidance processes to click into place. An excellent match between the learner's and advisor's expert profiles appears to be especially critical for achieving successful guidance and powerful knowledge exchange in emerging fields. However, finding an optimal learner–advisor match is often challenging. Many problems are presumably solved if these 'right persons' can be found and if the trainees are themselves oriented towards utilising the novel resources provided to them by their advisors.

5 Main findings and discussion

The aim of this study was to examine efforts to bridge academic and working life expertise in continuing professional education in the context of one traditional and one emerging field in response to the new requirements of the changing world and working life contexts. A need to create new learning solutions based on close collaboration and partnerships between education and work and to deliberately focus on building and advancing the knowledge necessary for future professional challenges has been recognised in recent research (Billett & Henderson, 2011; Harteis, Rausch, & Seifried, 2014; Jensen, Lahn, & Nerland, 2012; Kessels & Kwakman, 2007; Mustonen & Hakkarainen, 2015). In this dissertation, the phenomenon of interconnecting education and work was examined in the contexts of two continuing professional training designs one representing the emerging field of energy efficiency and the other representing the traditional profession of diplomacy. In both contexts, workers face novel professional challenges and operate in turbulent working environments; thus, they are required to continuously update their skills and expertise. Bridging the academic and working life settings in the contexts of these continuing professional education designs was examined from three perspectives: 1) the development of professional social networks; 2) the role of the learner's orientation towards expertise in terms of deliberate knowledge enhancing, problematising and knowledge building; and 3) interconnections of academic and workplace expertise achieved through guidance from more experienced actors.

Overall, the study illustrated that the practical needs of workplaces and the scientific viewpoints and standards of the academic world do not necessarily meet without friction when trying to find new forms of cooperation between higher education and working life. Tensions are likely to reflect the fundamental differences between different knowledge and working cultures and environments, and they can arise at the intersections of disparate goals and priorities (Billett, 2008; Edwards, 2012; Knorr Cetina, 2001; Knorr Cetina & Reichmann, 2015; Nerland & Jensen, 2012). These differences seem to complicate the creation of comprehensive social networks and the development of fluent guidance processes. Altogether, this dissertation suggests that a readiness to overcome and negotiate the boundaries of different knowledge and working environments and cultures that are incommensurate in nature, as well as a willingness to rethink the ways in which competencies are developed, is necessary for educational institutions, workplaces and learners themselves to successfully interconnect learning between the education and working life contexts (see Nerland, 2012).

5.1 Professional networks at the interface of education and working life

The first research question of this dissertation was to examine the social networking of professionals at the interface of education and working life. To accomplish this

purpose, the structure and development of professional networks, the natures of key persons' personal networks and the features of key persons were analysed.

First, the results showed that, even though it is often taken for granted that professional education supports the development of professional networking ties among participants, networking and knowledge sharing must be actively developed and supported. Though creating versatile networking connections that cross the borders of scientific and practical settings is extremely important for solving complex professional problems and coping in transforming working environments, the development of comprehensive professional social networks, or even single networking connections, does not take place automatically at the interface of education and working life.

The results suggested that both the nature of the learning environment and the personal features of the learner play important roles in the development and utilisation of professional networks and networking connections. It seems that the supportive and expansive learning environment proposed by Evans et al. (2006) and Fuller and Unwin (2004a), even though originally applied in a different type of working environment, also enables learners to effectively integrate in professional social networks. It may also be that expansive and supportive workplace environments are more responsive to the application of knowledge and new practices.

Earlier studies have acknowledged that trainees' deliberate orientations towards and investments in learning play important roles in the development of expertise (Bereiter & Scardamalia, 1993; Billet, 2006; Ericsson, 2006). The results of Studies I, III and IV contribute to this body of work by suggesting that, in addition to the nature of the learning environment, learners' agentic efforts aimed at deliberately increasing their expertise and improving professional competence also play a critical role in the learners' participation in wide-reaching learning networks in workplace environments and educational contexts, as well as their creation and utilisation of heterogeneous personal network connections. Furthermore, in addition to learners' willingness to utilise diverse competencies reached through rich networking connections, workers have indicated relational expertise, which is understood as the capability to recognise the boundaries of one's own competence and the competencies of others and to productively tailor personal expertise to create shared competencies with other professionals, as a critical success factor (Edwards, 2010).

One of this dissertation's theoretical contributions is the introduction and elaboration of the concept of cognitive centrality. In particular, this study expands the use of this concept beyond its original context of small-group research (see, Kameda, Ohtsubo, & Takezawa, 1997; Stasser, Abele, & Vaughan Parsons, 2012). In this dissertation, the concept of cognitive centrality connects the perspectives of social networks and personal features by referring to those key professionals who are positioned in the middle of their professional social networks, have valuable and extended networking connections and, therefore, are more likely than others to provide other workers with new and relevant knowledge, competencies and assistance. The

results showed that cognitively central professionals are able to cross the boundaries of their immediate professional fields (see Akkerman et al., 2006) and, therefore, to create connections and mediate knowledge between the academic and workplace contexts. These individuals possess knowledge and competencies that are considered useful by actors from a variety of professional contexts and cultures. The results indicated that personal features, such as high levels of professional experience, are not sufficient on their own to make a person cognitively central. Cognitive centrality is also related to social context: that is, the organisations from which cognitively central actors come and how their expert profiles fit into the wider occupational context.

Overall, the results suggest that, especially in emerging fields, in which there are rarely other experts in the workplace, the successful creation of occupational social networks and heterogeneous personal networks bridging academic and workplace expertise provides workers with especially important resources for conducting their work and updating their expertise. Versatile networking connections provide workers with opportunities to interconnect knowledge from multiple fields and disciplines, which is important for achieving the complex and multidisciplinary knowledge objectives often found in emerging fields.

5.2 Learners' deliberate knowledge enhancing, problematising and knowledge building efforts

The second research question of the dissertation was to analyse whether and how learners' orientations towards expertise in terms of deliberate knowledge enhancing, problematising and knowledge building is related to the interconnections between academic and working life expertise. In this dissertation, learners' deliberate efforts to extend their skills and competencies to dynamically adapt to transforming professional environments was defined as an orientation towards adaptive expertise, following the approaches of Hatano and Inagaki (1986), Ericsson (2006) and Ohlsson (2011). More specifically, an orientation to adaptive expertise was defined as a professional's personal efforts to deliberately acquire knowledge and improve professional competence, seek alternative solutions for existing professional practices and become an active knowledge-building and networking actor in his or her professional field in order to reach the highest levels of professional competence.

In general, earlier studies have suggested that young and inexperienced workers are positioned at the periphery of workplace communities or professional social networks (Jablin, 2001; Lave & Wenger, 1991; Moreland & Levine, 2002). Those with the most senior individual experiences are often expected to have the strongest expertise and to be asked for help in professional problems (Nebus, 2006; Reagans, Argote, & Brooks, 2005). Therefore, advisory processes are traditionally examined from the perspective that older and more experienced workers guide newly qualified employees (Billett et al., 2012).

Against these general viewpoints and in accordance with Fuller and Unwin's (2004b) findings, the results of Studies I and III revealed that the positions of

newcomers and old-timers are neither pre-determined nor necessarily strictly fixed. Young workers with rather limited working experience may quickly acquire relatively strong expertise, move to the heart of the professional community or network and become important and cognitively central knowledge-mediating actors, bringing and passing new kinds of knowledge and competencies between different knowledge and working cultures. However, as the results suggested, one important condition for achieving this kind of central professional position is an actor's willingness and deliberate attempts to increase his or her expertise and to reach considerable professional capability, to promote the overall development of his or her professional field by systematically creating and sharing professional knowledge and to work for the diffusion of good practices. In other words, an actor must have a strong orientation towards adaptive expertise.

In addition, the results of Study IV suggested that a strong orientation towards adaptive expertise indicates an actor's willingness and capability to see the relevance of participating in versatile learning activities made possible by different environments, as well as his or her competence in relationally understanding how the expertise of others can be utilised and in deliberately initiating joint professional activities. These are important features influencing the quality of the learning process (see Edwards, 2010; Hakkarainen et al., 2016; van Zolingen et al., 2000) that also appear to further the interconnections between academic and practical expertise.

Further, the results of Study IV suggested that learners' strong orientations towards adaptive expertise represented a significant component in successful guidance processes. This effect was seen primarily in the academic context. Presumably, workers with strong orientations towards adaptive expertise have the readiness and capability to apply theoretical knowledge to their working practices. This dissertation proposes that this kind of own integrative activity is particularly important for professional learning in emerging fields, which lack both adequate professional practices or experienced experts in workplaces and established teaching programmes in educational institutions.

5.3 Interconnections through guidance from more experienced actors

The third research question of this dissertation was to examine how professional learning is supported at the interface of education and working life by more experienced actors and whether the interconnection between academic and workplace expertise occurs through these guidance practices. In addition, differences between the traditional and the emerging fields were examined.

First, Study I showed that, with regard to the traditional diplomatic profession, the most important advice and guidance were received from the more experienced colleagues in the departmental workplace community, though connections beyond this community and the whole organisation were also important for professional learning. The professional knowledge culture, organisational expertise and institutional memory were obviously transferred from older generations to younger generations through joint

discussions and the sharing of experiences (see Lave & Wenger, 1991; Orr, 1996). Study IV instead showed that, in the emerging field of energy efficiency, there were rarely other energy efficiency experts in the course participants' workplaces. Furthermore, these workplaces generally were not able to provide specialised field-specific knowledge or opportunities for learning complex competencies, nor to create a supportive learning environment through the provision of resources, discussions or support. Therefore, the academic advisor appointed by the university had often the most important role in facilitating the participants' professional learning (see Hughes, 2004). Clearly, these circumstances reflect the differences between the fields' epistemic cultures and the entrenchment of the field-specific knowledge base. In traditional fields, workers can socialise to an existing knowledge base, and new practices and knowledge that need to be created due to the changing requirements of society and working life are developed on the basis of prior knowledge structures. In energy efficiency, as is also typical for other emerging fields (Palonen, Boshuizen, & Lehtinen, 2014), there are not yet any established, profession-specific ways of approaching, producing, distributing, validating or applying knowledge. Instead, epistemic cultures and practices, which are multi-professional in nature, are created and continuously cultivated through daily work.

Further, the results showed that the features of successful guidance process were related to the personal, dyad and context levels. That is, the process of successful guidance is affected by features of the learner, the advisor and their interaction, as well as by features of the learning environment and the nature of knowledge. The bases for a successful guidance process, which included regular meetings; an accessible, helpful and dedicated advisor; a committed trainee; and clear aims for the guidance, seemed to be similar across both emerging and traditional fields (see Barnes, Williams, & Archer, 2010; Boud & Costley, 2007; Vanthournout et al., 2014). However, Study IV revealed that these features alone are not sufficient in emerging fields, in which the professional knowledge is complex, multidisciplinary and highly specialised, and which, as with the field of energy efficiency, constantly generate new questions and become infinitely more complex when approached (Knorr-Cetina, 2001). The results showed that, in the field of energy efficiency, an excellent match between the expert profiles of the learner and the advisor (i.e., a match between the trainee's needs and the advisor's special field of expertise) was especially critical for successful guidance. Finding the right people appears to be eminently important if a field is scattered, since there are not necessarily many actors in the field and since the knowledge of where these actors are located is not always readily available (see Eraut, 2007)

Study IV introduced the procedure of two advisors as a new learning solution to support the interconnection between practical working life competence and theoretical knowledge in continuing professional education. The procedures of the two advisors, which comprised a professional advisor from each participant's workplace organisation and an academic advisor from each participant's university, were expected to provide the participants with solid research-based and practical knowledge to assist them in

deepening their professional skills and competencies. In accordance with the results of earlier studies conducted in the higher education context (Endedijk & Bronkhorst, 2014; Poortman et al., 2014) the results showed that actual and concrete interconnections of academic and workplace settings through guidance practices did not take place. However, it should be acknowledged that interconnections through actual social interactions with the advisors was not a necessary prerequisite for the exchange of knowledge—or, at least, of a single individual's mind—across the different environments and knowledge cultures. The results indicated that having two advisors representing two different professional perspectives helped the course participants find ways of connecting theoretical knowledge to their practical work tasks.

5.4 Methodological implications

This study has several methodological implications. First, the adopted mixed methods approach appeared to be useful. Combining multiple qualitative and quantitative methods that complemented one another yielded a better understanding of the processes related to professional learning and development in complex environments and at the interface of academic and workplace settings (Creswell & Plano Clark, 2007; Johnson & Onwuegbuzie, 2004). In addition, the mixed methods approach enabled an analysis of the phenomenon at different levels and from different perspectives, thus facilitating a deeper understanding than would have been possible by relying on single method. The social networking methods used allowed us to examine social structures and interactions at four different levels: 1) the overall network level, 2) the group level, 3) the individual level and 4) the ego network level. Several interviews, most of which were conducted repeatedly, produced qualitative data that further deepened our understanding of the processes behind the revealed networking structures and properties. Last, the event sampling methods used in Study I allowed us to repeatedly collect information about the participants' prevailing everyday experiences instead of asking them to recall old events and experiences (Reis & Gable, 2000).

Second, this study adopted a multilevel approach and demonstrated its potential value for studying professional knowledge exchange and professional social networks in complex environments. Therefore, this dissertation sought to overcome the limitations of previous knowledge network research, which has focused mainly on single levels of analysis (see Phelps, Heidl, & Wadhwa, 2012). The analyses were conducted at the community, group and personal levels, as well as at the process level. Studies II through IV gradually deepened the perspective and the level of analysis, which progressed from a more general examination of network structures and properties, to a detailed exploration of the personal networks of key persons and, finally, to the bilateral relations between the course participants and their advisors.

Third, the research design of this study was longitudinal. All data collection methods relied on repeated measures and allowed us to examine changes that took

place during the training programmes. It is essential that the evaluation of the change in the social networking ties (Studies II–IV) was based on the social networking data and not only on the participants' self-estimations. The event sampling data (Study I) and the interviews that were conducted twice to explore the energy efficiency training programme (Studies II–IV) enabled us to examine how the process of change was experienced by the participants.

Fourth, this dissertation demonstrated the potential value of the personal network approach for studying the personal and social features of professional knowledge exchange in complex environments. It explained how cognitively central key persons, who play essential roles in knowledge exchange, can be identified using networking methods. In addition, personal networks are often studied via egocentric network interviews, in which participants (egos) are asked to list the alters belonging to their personal networks and to evaluate the relationships between themselves and these alters, as well as between each individual pair of alters. In Study III, we used the overall network data to examine the key persons' personal networks. This approach allowed us to use ties incoming from other course participants to estimate cognitive centrality, to analyse the structure of these personal networks (McCarty & Govindaramanujam, 2005) and to visualise the networks on both the overall (sociocentric) and personal levels (see McCarty et al., 2007).

5.5 Practical implications

This dissertation also has practical implications for organising continuing professional education. First, the continuing professional education programmes that are organised at the intersection of educational institutions and working life could provide workers with greater flexibility in terms of developing their expertise. Workers seeking to expand their professional competencies have typically completed several academic and professional degrees (Suikkanen et al., 2001) and, therefore, have taken seats that could otherwise be given to people who do not yet have degrees. Therefore, it is proposed that these continuing professional training programmes would be particularly suitable for educating professionals who are already engaged in working life and who need to learn novel competencies to expand their expertise. In addition, the continuing professional training programmes organised at the interface of education and working life could play an especially important role in emerging fields, where there is a lack of certified knowledge and shared professional standards and where there are no established education programmes for developing expertise.

Second, this dissertation revealed both strengths and weaknesses of organising education, which should be taken into consideration when developing future continuing professional training programmes at the interface of education and work. The most essential strength of the energy efficiency training programme appeared to be the multi-disciplinarity and heterogeneity of the education in terms of the participating workplace organisations; the participants' working sectors, professional domains and profiles; and the levels of associated professional experiences. However, achieving

successful collaboration and construction of a networked community by crossing the boundaries between heterogeneous professional cultures and practices requires planning and sustained efforts, since, as the results revealed, participant heterogeneity may hinder interactions and the identification of common interests. In addition, future education could benefit from efforts to address the central weaknesses identified in the energy efficiency training: its relatively short training period, the low number of contact days and the challenges related to the guidance processes. Overall, the results indicated that shared standards and guidelines need to be created to improve the quality of the education and to provide a uniform learning environment for the participants.

Third, the factors underlying successful guidance process in both the academic and the workplace settings were identified. Above all, the results highlight the importance of finding a right, competent and dedicated advisor. It seems that finding well-matched trainees and advisors might also ensure regular and goal-oriented advisory practices, which could become natural parts of daily practice instead of remaining as simply external actions or sources of inert knowledge. If this situation is achieved, the hierarchical relationship between advisors and learners that is characteristic of many expert networks and workplaces could transform into an interlocutor relationship between two experts. Therefore, in future educational initiatives, it is particularly important to invest in finding matching and committed advisors in both the education and workplace contexts.

Fourth, this dissertation introduced a procedure of using two advisors that seems to be a valuable method for bringing both academic and workplace contexts and theoretical and practical knowledge closer to one another, thereby supporting workers in preparing to meet the new requirements of a changing world and their future working lives. At best, the two-advisor procedure enables interconnections among different kinds of knowledge environments and working practices and supports workers in developing novel and cutting-edge competencies, new working tools and innovations for their daily work. However, this procedure also requires that several different aspects of successful guidance processes click into place. Above all, the right people must be found, and the trainees themselves must be oriented towards utilising the novel resources provided to them. In the future, recognising the prerequisites for successful guidance processes could help to further develop the two-advisor procedure and to ensure the uniform quality of the guidance processes. In addition, the procedure of providing advisors from both academic and workplace settings could be extended to other training programmes that operate at the interface of working life and education, such as professional specialisation programmes.

Fifth, there must be readiness in the workplaces to organise qualified guidance—or, at least, a willingness to support trainees' efforts to apply the theoretical knowledge provided by the universities to their working practices. Therefore, in future educational initiatives, special attention should be paid to ensuring sufficient diversity in the working context.

Sixth, in addition to physical resources, networked environments can provide repositories useful in creating rich and powerful learning environments. Single working organisations or educational institutions are seldom strong enough to implement such environments; however, this is certainly a topic for future investigation and consideration.

5.6 Limitations and directions for future research

There are some limitations that should be taken into consideration when interpreting the results of this study and designing future research. Although this study relied on extensive quantitative and qualitative data, only two professional training courses were studied. Therefore, more wide-ranging research focusing on a variety of training designs and fields is needed to study whether the results found are typical only for the examined fields or whether they are also generalisable to other contexts. Based on the two studied training programmes, it is difficult to conclude whether the observed differences were due to the disparity between the established and emerging professional fields or to other aspects.

This study also faced certain methodological limitations. Studies II through IV, which examined the connections to working life, were based solely on interviews with the course participants and a limited number of interviews with the workplace advisors. It would have been fruitful to further examine these relations by, for example, collecting social networking data from the participants' workplaces. Furthermore, the data regarding the participants' understandings of the epistemic nature of their work and discipline could have been collected more explicitly to better understand their relation to the learning processes taking place between the educational and the practical contexts.

Regarding Study I, the networking data were gathered only once during the training period. It would have been beneficial to conduct the networking questionnaire at least two times across the training period in order to examine the development in the network structures, as we did when examining the energy efficiency training programme.

Even though the response rate for of the social networking questionnaire conducted in the context of the energy efficiency training programme (pre-questionnaire: 72%; post-questionnaire: 70%) can be considered excellent for a questionnaire survey (Baruch & Holtom, 2008), it should be noted that the lack of response from some course participants may have affected the results of Studies II and III. In addition, in Study III, two of the central participants did not respond to the networking questionnaire. Therefore, their data were amalgamated solely from information given by the other course participants, and we were not able to examine the relationships that these central participants may have had with others.

It is difficult to evaluate professionals' actual levels of adaptive expertise. In Study IV, the participants' levels of adaptive expertise were observed through interview data alone. Thus, the nature of the participants' expertise was assessed solely

through self-reports. In addition, only a limited number of participants were interviewed, and none of the advisors of the interviewed course participants could be reached for interviews. Therefore, the information regarding the success of the guidance processes and the interconnections between the academic and workplace settings was based solely on the experiences of the course participants.

The findings of this dissertation raise new questions for future research. First, the study showed that developing training designs to support actual interconnections between the academic and practical knowledge cultures and the development of networking connections among participants from the different working environments is difficult. Future research could help to overcome these obstacles by aiming to find successful examples of initiatives bringing these contexts closer to one another and creating bridges and linkages between the workers of these two contexts, instead of only identifying the problems and complications.

Second, though this dissertation used a repeated data collection design, in future studies, it would be beneficial to develop more longitudinal and process-oriented ways to analyse both the development of professional learning networks and the process of learning (e.g. to examine whether the created professional networking connections continue to exist following training). Overall, in order to better understand the processes of professional development in complex and changing environments, it is important to simultaneously examine the learning process at the individual level, the development of professional social networks, the knowledge dimensions of the professional work and the interconnections among these aspects. It would beneficial to include a job performance measure in the social network questionnaire, even though measuring individual performance may be difficult in complex and incommensurate working environments. In addition, future research could examine in more depth how individuals are able to connect expertise from one specific field with the diverse expertise of their multi-professional networks, how local knowledge is linked to collective knowledge networks and through what kinds of processes these interconnections take place.

This dissertation focused on social networking aspects at different levels to examine professional learning at the interface of academic and practice settings. In the future, it will be important to more closely examine how the knowledge aspects of the expert work affect this process. That is, future work should explore how the natures of the workers' knowledge objectives, the knowledge resources and systems in which they are involved and the broader profession-specific standards create the settings for the professional work. It should further be examined how experts utilise and connect occupational, scientific and practical knowledge in their work.

Finally, more research is needed to better understand the phenomenon of cognitive centrality. For example, it is important to further explore what kinds of individual and communal attributes and broader context factors are related to the phenomenon. Future studies should examine in detail which kinds of advice are sought from cognitively central participants and how this advice is related to the nature of

their expertise. In addition, it has been revealed that more experienced persons (e.g. advisors) play an important role in professional learning; thus, future studies should examine the kinds of mechanisms through which the right people find one another and begin collaborating.

6 References

Akhavan, P., & Hosseini, S. M. (2015). Determinants of knowledge sharing in knowledge networks: a social capital perspective. *The IUP Journal of Knowledge Management, 13*, 7–24.

Akkerman, S., Admiraal, W., Simons, R. J., & Niessen, T. (2006). Considering diversity: multivoicedness in international academic collaboration. *Culture & Psychology, 12*, 461–485. doi: 10.1177/1354067X06069947

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research, 81*, 132–169. doi: 10.3102/0034654311404435

Barabási, A.-L. (2002). Linked: how everything is connected to everything else and what it means for business, science, and everyday life. Cambridge, MA: Perseus Publishing.

Barnes, B. J., Williams, E. A., & Archer, S. A. (2010). Characteristics that matter most: doctoral students' perceptions of positive and negative advisor attributes. *NACADA Journal, 30*, 34–46. doi: http://dx.doi.org/10.12930/0271-9517-30.1.34

Baruch, Y., & Holtom, B. C. (2008). Survey response rate levels and trends in organizational research. *Human Relations, 61*, 1139–1160. doi: 10.1177/0018726708094863

Bereiter, C., & Scardamalia, M. (1993). Surpassing ourselves. An inquiry into the nature and implications of expertise. Chicago: Open Court.

Billett, S. (2006). Relational interdependence between social and individual agency in work and working life. *Mind, Culture and Activity, 13*, 53–69. doi: 10.1207/s15327884mca1301_5

Billett, S. (2008). Realising the educational worth of integrating work experiences in higher education. *Studies in Higher Education, 34*, 827-843. doi: 10.1080/03075070802706561

Billett, S. (2012). Conceptualising lifelong learning in contemporary times. In T. Halttunen, M. Koivisto, & S. Billett (Eds.), *Promoting, assessing, recognizing and certifying lifelong learning* (pp. 19–35). Dordrecht: Springer.

Billett, S. (2014). Interdependence on the boundaries between working and learning. In C. Harteis, A. Rausch, & J. Seifried (Eds.), *Discourses on professional learning. On the boundary between learning and working* (pp. 369–385). Dordrecht: Springer.

Billett, S., & Henderson, A. (Eds.). (2011). *Developing learning professionals.* London: Springer.

Billett, S., Henderson, A., Choy, S., Dymock, D., Kelly, A., Smith, R., James, I., Beven, F., & Lewis, J. (2012). *Continuing education and training models and strategies: an initial appraisal.* Adelaide: NCVER

Billett, S., & Pavlova, M. (2005). Learning through working life: self and individuals' agentic action. *International Journal of Lifelong Education, 24*, 195–211. doi: 10.1080/02601370500134891

Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: capturing life as it is lived. *Annual Review of Psychology, 54*, 579–616. doi: 10.1146/annurev.psych.54.101601.145030

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *UCINET 6 for Windows. Software for social network analysis. User's guide.* Harvard: Analytic Technologies.

Borgatti, S. P., Mehra, A., Brass, J. P., & Labianca, G. (2009). Network analysis in the social sciences. *Science, 323*, 892–895. doi: 10.1126/science.1165821

Boud, D., & Costley, C. (2007). From project supervision to advising: new conceptions of the practice. *Innovations in Education and Teaching International, 44*, 119–130. doi:10.1080/14703290701241034.

Bromme, R., & Tillema, H. H. (1995). Fusing experience and theory: the structure of professional knowledge. *Learning and Instruction, 5*, 261¬267.

Brown, J. S., Denning, S., Groh, K., & Prusak, L. (2005). Storytelling in organizations. Why Storytelling is transforming 21st century organizations and management. Burlington: Elsevier.

Burt, R. S. (1999). Entrepreneurs, distrust, and third parties: a strategic look at the dark side of dense networks. In L. L. Thompson, J. M. Levine, & D. M. Messick (Eds.), *Shared cognition in organizations: the management of knowledge* (pp. 213–243). Mahwah, NJ: Erlbaum.

Carlile, P. R. (2004). Transferring, translating, and transforming: an integrative framework for managing knowledge across boundaries. *Organization Science, 15*, 555–568.

Choy, S., Smith, R., & Kelly, A. (2014). Continuing education and training at work. In T. Halttunen, M. Koivisto, & S. Billett (Eds.), *Promoting, assessing, recognizing and certifying lifelong learning* (pp. 151–171). Dordrecht: Springer.

Costley, C., & Lester, S. (2012). Work-based doctorates: professional extension at the highest levels. *Studies in Higher Education, 37*, 257–269. doi: 10.1080/03075079.2010.503344

Creswell, J., & Plano Clark, V. L. (2007). *Designing and conducting mixed method research.* Thounsand Oaks, CA: Sage.

Davies, A., Fidler, D., & Gorbis, M. (2011). *Future work skills 2020.* Phoenix: Institute for the Future for University of Phoenix Research Institute.

Edwards, A. (2010). Being an expert professional practitioner. London: Springer.

Edwards, A. (2012). The role of common knowledge in achieving collaboration across practices. *Learning, Culture, and Social Interaction, 1*, 22–32. doi: 10.1016/j.lcsi.2012.03.003

Endedijk, M. D., & Bronkhorst, L. H. (2014). Students' learning activities within and between the context of education and work. *Vocations and Learning, 7*, 289–311. doi: 10.1007/s12186-014-9116-x

Eraut, M. (2004). Informal learning in the workplace. *Studies in Continuing Education, 26*, 247–273. doi: 10.1080/158037042000225245

Eraut, M. (2007). Learning from other people in the workplace. *Oxford Review of Education, 33*, 403–422. doi: 10.1080/03054980701425706

Ericsson, K. A. (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, N. Charness, P. Feltovich, & R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 683–703). Cambridge: Cambridge University Press.

Evans, K., Hodkinson, P., Rainbird, H., & Unwin, L. (2006). *Improving workplace learning.* New York: Routledge.

Facer, K. (2011). Learning futures. Education, technology and social change. London: Routledge.

Fenwick, T. (2012). Learning among older professional workers: knowledge strategies and knowledge orientations. *Vocations and Learning, 5*, 203–223.doi: 10.1007/s12186-012-9074-0

Fourcade, M. (2006). The construction of a global profession: the transnationalization of economics. *American Journal of Sociology, 1*, 145–194.doi: 10.1086/502693

Fuller, A., & Unwin, L. (2004a). Expansive learning environments: integrating organizational and personal development. In H. Rainbird, A. Fuller, & A. Munro (Eds.), *Workplace learning in context* (pp. 126–144). London: Routledge.

Fuller, A., & Unwin, L. (2004b). Young people as teachers and learners in the workplace: challenging the novice-expert dichotomy. *International Journal of Training and Development, 8*, 32–42. doi: 10.1111/j.1360-3736.2004.00194.x

Gardner, H., Csikszentmihalyi, M., & Damon, W. (2001*). Good work: when excellence and ethics meet.* New York: Basic Books.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: the dynamics of science and research in contemporary societies.* London: Sage.

Gijselaers, W.H., Dailey-Hebert, A., & Niculescu, A. (2013). Shaping the new professional for the new professions. In S. Baroncelli, R. Farneti, I. Horga, & S. Vanhoonacker (Eds.), *Teaching and learning the European Union: traditional and innovative methods* (pp. 15–40). Dordrecht/Boston/London: Springer.

Gruber, H., Lehtinen, E., Palonen, T., & Degner, S. (2008). Persons in shadow: assessing the social context of high abilities. *Psychology Science Quarterly, 50*, 237–258.

Hakkarainen, K. (2013). Mapping the research ground: expertise, collective creativity, and shared knowledge practices. In H. Gaunt, & H. Westerlund (Eds.), *Collaborative learning in higher music education* (pp. 13–26). Surrey: Ashgate.

Hakkarainen, K., Hytönen, K., Vekkaila, J., & Palonen, T. (2016). Networked expertise, relational agency, and collective creativity. In A. Edwards (Eds.), *Collaborating on complex problems: cultural-historical accounts of relational work.* Cambridge: Cambridge University Press.

Hakkarainen, K., Lallimo, J., Toikka, S., & White, H. (2011). Cultivating collective expertise within innovative knowledge-practice networks. In S. Ludvigsen, A. Lund, I. Rasmussen, & R. Säljö (Eds.), *Learning across sites: new tools, infrastructures and practices.* Earli series: new perspectives on learning and instruction (pp. 69–86). New York: Routledge.

Hakkarainen K., Palonen, T., Paavola, S., & Lehtinen, E. (2004). *Communities of networked expertise. Professional and educational perspectives.* Sitra's Publication series, publication no. 257. Oxford: Elsevier.

Harteis, C., Rausch, A., & Seifried, J. (Eds.). (2014). Discourses on professional learning. On the boundary between learning and working. Dordrecht: Springer.

Hatano, G., & Inagaki, K. (1986). Two courses of expertise. In H. A. H. Stevenson & K. Hakuta (Eds.), *Child development and education in Japan* (pp. 262–272). New York: Freeman.

Howells, J. (1998). Management and the hybridization of expertise in network design. In R. Williams, W. Faulkner, & J. Fleck (Eds.), *Exploring expertise: issues and perspectives* (pp. 265–284). London: Macmillian.

Hughes, C. (2004). The supervisor's influence on workplace learning. *Studies in Continuing Education, 26*, 275–287. doi:10.1080/158037042000225254.

Hytönen, K., Hakkarainen, K., & Palonen, T. (2011). Young diplomats' socialization to the networked professional cultures of their workplace communities. *Vocations and Learning, 4*, 253–273. doi: 10.1007/s12186-011-9061-x

Hytönen, K., Palonen, T., & Hakkarainen, K. (2014). Cognitively central actors and their personal networks in an energy efficiency training program. *Frontline Learning Research, 2*, 15–37. doi: http://dx.doi.org/10.14786/flr.v2i2.90

Hytönen, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2014). Does academic apprenticeship increase networking ties among participants? A case study of an energy efficiency training program. *Higher Education, 68, 6*, 959–976. doi: 10.1007/s10734-014-9754-9

Hytönen, K., Palonen, T., Lehtinen, E., & Hakkarainen, K. (2016). Between two advisors: interconnecting academic and workplace settings in an emerging field. *Vocations and Learning, 9*, 333–359. doi: 10.1007/s12186-016-9156-5

Hytönen, T., & Tynjälä, P. (2005). A learning network promoting knowledge management. Paper presented at the Researching Work and Learning Conference RWL05, Sydney, Australia.

Jablin, F. M. (2001). Organizational entry, assimilation, and disengagement/exit. In F. M. Jablin & L. M. Putnam (Eds.), *The new handbook of organizational communication: advances in theory, research, and methods* (pp. 732–818). Thousand Oaks: Sage.

Jensen, K., Lahn, L. C., & Nerland, M. (2012). *Professional learning in the knowledge society.* Rotterdam: Sense Publishers.

Jensen, K., & Nerland, M. (2015). Knowledge dynamics in higher education. Examples from law schools in Norway and their shadow arrangements. In I. Langemeyer, M. Fischer, M. Pfadenhauer (Eds.), *Epistemic and learning cultures* (pp. 46–60). Beltz Verlag: Weinheim Basel.

Jensen, K., Nerland, M., & Enqvist-Jensen, C. (2015). Enrolment of newcomers in expert cultures: an analysis of epistemic practices in a legal education introductory course. *Higher Education, 70*, 867–880. doi: 10.1007/s10734-015-9872-z

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: a research paradigm whose time has come. *Educational Researcher, 33*, 14–26.doi: 10.3102/0013189X033007014

Kameda, T., Ohtsubo, Y., & Takezawa, M. (1997). Centrality on sociocognitive networks and social influence: an illustration in a group decision-making context. *Journal of Personality and Social Psychology, 73*, 296–309. doi: 10.1037/0022-3514.73.2.296

Kessels, J., & Kwakman, K. (2007). Interface: establishing knowledge networks between higher vocational education and business. *Higher Education, 54*, 689–703. doi: 10.1007/s10734-006-9018-4

Kleinbaum, A. M., Stuart, T. E., & Tushman, M. L. (2013). Discretion within constraint: homophily and structure in a formal organization. *Organization Science, 24*, 1316–1336.

Knorr Cetina, K. (1999). *Epistemic cultures: how the science make knowledge.* Cambridge, MA: Harvard University Press.

Knorr-Cetina, K. (2001). Objectual practices. In T. Schatzki, K. Knorr-Cetina, & E. Von Sa-vigny (Eds.), *The practice turn in contemporary theory* (pp. 175–188). London: Routledge.

Knorr Cetina, K., & Reichmann, W. (2015). Professional epistemic cultures. In I. Langemeyer, M. Fischer, & M. Pfadenhauer (Eds.), *Epistemic and learning cultures* (pp. 18–33). Beltz Verlag: Weinheim Basel.

Korkeakoulutettujen oppisopimustyyppiset täydennyskoulutukset. (2010). Kyselyn tiivistelmä. Futurex-hanke. Retrieved from http://futurex.utu.fi/julkaisut_tiivistelma-taydennyskoulutukset_2010.pdf

Krueger, T., Page, T., Hubacek, K., Smith, L., & Hiscock, K. (2012). The role of expert opinion in environmental modelling. *Environmental Modelling & Software, 36*, 4–18. doi:10.1016/j.envsoft.2012.01.011

Lave, J., & Wenger, E. (1991). *Situated learning: legitimate peripheral participation.* Cambridge: Cambridge University Press.

Lehtinen, E., Hakkarainen, K., & Palonen, T. (2014). Understanding learning for the professions: how theories of learning explain coping with rapid change. In S. Billett, C. Harteis, & H. Gruber (Eds.), *International handbook of research in professional and practice-based learning* (pp. 199–224). Dordrecht: Springer.

Lin, N. (2001). *Social capital*. Cambridge: Cambridge University Press.

Lozares, C., Verd, J. M., Cruz, I., & Barranco, O. (2013). Homophily and heterophily in personal networks. From mutual acquaintance to relationship intensity. *Quality & Quantity, 48*, 2657-2670. doi: 10.1007/s11135-013-9915-4.

McCarty, C., & Govindaramanujam, S. (2005). A modified elicitation of personal networks using dynamic visualization. *Connections, 26*, 61–69.

McCarty, C., Molina, J. L., Aguilar, C., & Rota, L. (2007). A comparison of social network mapping and personal network visualization. *Field Methods, 19*, 145–162. doi: 10.1177/1525822X06298592

McPherson, M., Smith-Lovin, L., & Cook, J. (2001). Birds of a feather: homophily in social networks. *Annual Review of Sociology, 27*, 415–444.

Mieg, H. A. (2006). Social and sociological factors in the development of expertise. In K. A. Ericsson, N. Charness, P. Feltovich, & R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 743–760). Cambridge: Cambridge University Press.

Moreland, R. L., & Levine, J. M. (2002). Socialization and trust in work groups. *Group Processes & Intergroup Relations, 5*, 185–201. doi: 10.1177/1368430202005003001

Morrison, A. (2008). Gatekeepers of knowledge within industrial districts: who they are, how they interact. *Regional Studies, 42*, 817–835. doi: 10.1080/00343400701654178

Mørk, B. E., Aanestad, M., Hanseth, O., & Grisot, M. (2008). Conflicting epistemic cultures and obstacles for learning across communities of practice. *Knowledge and Process Management, 15*, 12–23. doi: 10.1002/kpm.295

Mulder, M., Gulikers, J., Biemans, H., & Wesselink, R. (2009). The new competence concept in higher education: error or enrichment? *Journal of European Industrial Training, 33*, 755–770.

Mustonen V., & Hakkarainen, K. (2015). Tracing two apprentices' trajectories toward adaptive professional expertise in fingerprint examination. *Vocations and Learning, 8*, 185–211. doi: 10.1007/s12186-015-9130-7

Nardi, B. A., Whittaker, S., & Schwarz, H. (2000). It's not what you know, it's who you know: work in the information age. *First Monday, 5*.

Nebus, J. (2006). Building collegial information networks: a theory of advice network generation. *The Academy of Management Review, 31*, 615–637. doi 10.2307/20159232

Nerland, M. (2012). Professions as knowledge cultures. In K. Jensen, L. C. Lahn, & M. Nerland (Eds.), *Professional learning in the knowledge society* (pp. 27–48). Rotterdam: Sense Publishers.

Nerland, M., & Jensen, K. (2012). Epistemic practices and object relations in professional work. *Journal of Education and Work, 25*, 101–120. doi: 10.1080/13639080.2012.644909

Nooteboom, B. (2004). Inter-firm collaboration, learning and networks. An integrated approach. NewYork, NY: Routledge.

Novotny, H. (2003). Dilemma of expertise. Democratising expertise and socially robust knowledge. *Science and Public Policy, 30*, 151–156. doi: 10.3152/147154303781780461

Ohlsson, S. (2011). *Deep learning. How the mind overrides experience.* New York: Cambridge University Press.

Orr, J. E. (1996). Talking about machines: an ethnography of a modern job. New York: ILR Press.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of Educational Research, 74*, 557–576. doi: 10.3102/00346543074004557

Palonen, T., Boshuizen, H. P., & Lehtinen, E. (2014). How expertise is created in emerging professional fields. In T. Halttunen, M. Koivisto, & S. Billett (Eds.), *Promoting, assessing, recognizing and certifying lifelong learning* (pp. 131–149). Dordrecht: Springer.

Palonen, T., & Hakkarainen, K. (2014). Social network analyses of learning at workplaces. In C. Harteis, A. Rausch, & J. Seifried (Eds.), *Discourses on professional learning. On the boundary between learning and working* (pp. 293–315). Dordrecht: Springer.

Palonen, T., Hakkarainen, K., Talvitie, J., & Lehtinen, E. (2004). Network ties, cognitive centrality, and team interaction within a telecommunication company. In H. P. A. Boshuizen, R. Bromme, & H. Gruber (Eds.), *Professional learning: gaps and transitions on the way from novice to expert* (pp. 271 – 294). Dordrecht: Kluwer Academic Publisher.

Reagans, R. (2011). Close encounters: analyzing how social similarity and propinquity contribute to strong network connections. *Organization Science, 22*, 835–849.

Reagans, R., Argote, L., & Brooks, D. (2005). Individual experience and working together: predicting learning rates from knowing who knows what and knowing how to work together. *Management Science, 51*, 869–881. doi: 10.1287/mnsc.1050.0366

Redecker, C., Leis, M., Leendertse, M., Punie, Y., Gijsbers, G., Kirschner, P., Stoyanov, S., & Hoogveld, B. (2010). *The future of learning: new ways to learn new skills for future jobs. Results from an online expert consultation*. Luxemburg: Publications office of the European Union.

Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 190–222). Cambridge: Cambridge University Press.

Phelps, C., Heidl, R., & Wadhwa, A. (2012). Knowledge, networks, and knowledge networks: a review and research agenda. *Journal of Management, 38*, 1115–1166. doi: 10.1177/0149206311432640

Rienties, B., Héliot, Y., & Jindal-Snape, D. (2013). Understanding social learning relations of international students in a large classroom using social network analysis. *Higher Education, 66*, 489–504. doi: 10.1007/s10734-013-9617-9.

Rienties, B., Nanclares, N. H., Hommes, J., & Veermans, K. (2014). Understanding emerging knowledge spillovers in small-group learning settings: a networked learning perspective. In V. Hodgson, D. McConnell, & M. De Laat (Eds.), *Exploring the theory, pedagogy and practice of networked learning* (pp. 127–147). The Netherlands: Springer.

Poortman, C. L., Reenalda, M., Nijhof, W. J., & Nieuwenhuis, L. F. M. (2014). Workplace learning in dual higher professional education. *Vocations and Learning, 7*, 176–190. doi: 10.1007/s12186-014-9111-2

Roxå, T., Mårtensson, K., & Alveteg, M. (2011). Understanding and influencing teaching and learning cultures at university: a network approach. *Higher Education, 62*, 99–111. doi: 10.1007/s10734-010-9368-9

Scott, J. (1991). Social network analysis: a handbook. London: Sage.

Sparrowe, R. T., Liden, R. C., Wayne, S. J., & Kraimer, M. L. (2001). Social networks and the performance of individuals and groups. *Academy of Management Journal, 44*, 316–325. doi: 10.2307/3069458

Stasser, G., Abele, S., & Vaughan Parsons, S. (2012). Information flow and influence in collective choice. *Group Processes and Intergroup Relations, 15*, 619–635. doi: 10.1177/1368430212453631.

Suikkanen, A., Linnakangas, R., Martti, S., & Karjalainen, A. (2001). *Siirtymien palkkatyö*. Sitran raportteja 16. Helsinki: Hakapaino.

Svendsen, A. C., & Laberge, M. (2005). Convening stakeholder networks: a new way of thinking, being and engaging. *Journal of Corporate Citizenship, 19*, 91–104. doi: http://dx.doi.org/10.9774/GLEAF.4700.2005.au.00013

Sverrisson, Á. (2001). Translation networks, knowledge brokers and novelty construction: pragmatic environmentalism in Sweden. *Acta Sociologica, 44*, 313–327. doi: 10.1177/000169930104400403

Talwar, R., & Hancock, T. (2010). The shape of jobs to come. Possible new careers emerging from advances in science and technology (2010–2030). Final Report. Fast Future Research.

Trede, F., & McEwen, C., (2016). *Educating the deliberate professional. Preparing for future practice.* New York: Springer. doi: 10.1007/978-3-319-32958-1

Tynjälä, P. (2013). Toward a 3-P model of workplace learning: a literature review. *Vocations and Learning, 6*, 11–36. doi: 10.1007/s12186-012-9091-z

Tynjälä, P., Häkkinen, P., & Hämäläinen, R. (2014). TEL@work: toward integration of theory and practice. *British Journal of Educational Technology, 45*, 990–1000. doi: 10.1111/bjet.12164

Tynjälä, P., Välimaa, J., & Sarja, A. (2003). Pedagogical perspectives on the relationship between higher education and working life. *Higher Education, 46*, 147–166. doi: 10.1023/A:1024761820500

Vanthournout, G., Noyens, D., Gijbels, D., & Van den Bossche, P. (2014). The relationship between workplace climate, motivation and learning approaches for knowledge workers. *Vocations and Learning, 7*, 191–214. doi:10.1007/s12186-014-9112-1.

van Zolingen, S. J., Streumer, J. N., de Jong, R., & van der Klink, M. R. (2000). Implementing on-the-job training: critical success factors. *International Journal of Training and Development, 4*, 208–216. doi:10.1111/1468-2419.00108.

Vest, C. M. (2008). Context and challenge for twenty-first century engineering education. *Journal of Engineering Education, 97*, 235–236.

Virtanen, A., Tynjälä, P., & Eteläpelto, A. (2014). Factors promoting vocational students' learning at work: study on student experiences. *Journal of Education and Work, 27*, 43–70. doi: 10.1080/13639080.2012.718748

Välimaa, J. (2006). Analysing the relationship between higher education institutions and working life in Nordic context. In P. Tynjälä, J. Välimaa, & G. Boulton-Lewis (Eds.), *Higher education and working life. Collaborations, confrontations and challenges* (pp. 35–53). Oxford: Elsevier.

Wagner, E. L., & Newell, S. (2004). Best' for whom?: the tension between 'best practice' ERP packages and diverse epistemic cultures in a university context. *The Journal of Strategic Information Systems, 13*, 305–328. doi: 10.1016/j.jsis.2004.11.002

Wasserman, S., & Faust, K. (1994). *Social network analysis. Methods and applications.* Cambridge: Cambridge University Press.

World Economic Forum (2016). *The future of jobs. Employment, skills and workforce strategy for the fourth industrial revolution.* Global Challenge Insight Report. http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

Zappa, P., & Robins, G. (2016). Organizational learning across multi-level networks. *Social Networks, 44*, 295–306. doi: 10.1016/j.socnet.2015.03.003